REMARKS

I. Improper Finality of the Office Action

Applicants submit that the finality of the outstanding Office Action dated January 28, 2008, was improper.

M.P.E.P. § 706.07(a) states:

> Under present practice, second or any subsequent actions on merits shall be final, except where the examiner introduces a new ground of rejection that is neither necessitated by applicant's amendment of the claims, nor based on information submitted in an information disclosure statement filed during the period set forth in 37 C.F.R. § 1.97(c) with the fee set forth 37 C.F.R. § 1.17(p).

The outstanding Office Action was the second action on merits, and it introduced a new ground of rejection of claims 23, 24, 56, and 57 under 35 U.S.C. § 112, second paragraph. The new ground of rejection, however, was neither necessitated by Applicants' amendment of the claims, nor based on information submitted in an information disclosure statement filed during the period set forth in 37 C.F.R. § 1.97(c). No claim was amended in response to the first non-final Office Action, and no information disclosure statement was filed during the period set forth in 37 C.F.R. § 1.97(c). Thus, according to M.P.E.P. § 706.07(a), the outstanding Office Action does not meet the criteria for making the action final.

Consequently, Applicants respectfully request that the Examiner reconsider and withdraw the finality of the outstanding Office Action.

II. Examiner's Mischaracterization of Applicants' Arguments

The outstanding Office Action[1] sets forth a number of statements reflecting characterizations of Applicants' remarks allegedly made in response to the first non-final Office Action. For example, the outstanding Office Action alleges that (1) "Applicant now admits that what he labels as '...artificial intelligence engine...' are known to one of ordinary skill in the art; (2) "Applicant also appears to make a distinction between '...artificial intelligence engine...' and '...artificial intelligence...;'" and (3) "Applicant appears to argue that '...**artificial intelligence** engine...' does not always encompass '...**artificial intelligence...**'" Office Action at 2 (emphasis in original). Applicants respectfully submit that these statements appear to mischaracterize the remarks in Applicants' response to the first non-final Office Action. Applicants respectfully request that the Examiner identify where any such purported admission, distinction, and argument have been specifically made by Applicants.

III. Regarding Office Action

In the outstanding Office Action, claims 23, 24, 56, and 57 were rejected under 35 U.S.C. § 112, second paragraph; claims 1-10, 13-17, 21, 22, 25, 27-44, 47-55, 58, and 60-72 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,801,216 to Voticky et al. ("Voticky"); claims 11, 12, 18-20, 26, 45, 46, and 59 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Voticky in view of U.S.

[1] The outstanding Office Action contains a number of statements reflecting characterizations of Applicants' remarks made in response to the first non-final Office Action and characterizations of the related art and the claims. Regardless of whether any such statement is identified herein, Applicants decline to automatically subscribe to any statement or characterization in the outstanding Office Action.

Patent No. 6,937,755 to Orpaz et al. ("Orpaz"); and claims 23, 24, 56, and 57 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Voticky, Orpaz, and the allegedly admitted prior art.

Claims 1-72 are currently pending. Based on the following remarks, Applicants respectfully traverse the rejections of the pending claims.

A. § 112, Second Paragraph, Rejection of Claims 23, 24, 56, and 57

Claims 23, 24, 56, and 57 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Office Action at 6. In rejecting the claims, the Examiner appears to have misunderstood the meaning of the term "conventional artificial intelligence." Office Action at 4. The Examiner appears to have interpreted the term "conventional," as an adjective that describes "artificial intelligence" as being conventional. Id.

Applicants submit that the term "conventional artificial intelligence," as understood in the art, refers to a subfield of artificial intelligence, which is based on machine learning and concerned with techniques and algorithms that allow machines to learn or at least simulate learning. This is evidenced by the attached article titled "Overview and Tutorial on Artificial Intelligence Systems" by Jim Hurst (www.giac.org/resources/whitepaper/application/237.php) ("Hurst") at p. 2. Examples of "conventional artificial intelligence," as that term is understood in the art, include case-based reasoning, behavior-based artificial intelligence, Bayesian networks, and expert systems. Id.

As explained in the Reply to the first non-final Office Action dated August 6, 2007, the specification describes how the AI engine may learn to adapt to an unknown and/or changing environment for better performance:

> AI engines may be trained based on input such as product information, expert advice, user profile, or data based on sensory perceptions. Using input an AI engine may implement an iterative training process. Training may be based on a wide variety of learning rules or training algorithms. For example, the learning rules may include one or more of the following: back-propagation, real-time recurrent learning, pattern-by-pattern learning, supervised learning, interpolation, weighted sum, reinforced learning, temporal difference learning, unsupervised learning, or recording learning. **As a result of the training, AI engine may learn to modify its behavior in response to its environment, and obtain knowledge.** Knowledge may represent any information upon which AI engine may determine an appropriate response to new data or situations. Knowledge may represent, for example, relationship information between two or more products. Knowledge may be stored in any form at any convenient location, such as a database.

Page 52, line 15 - page 53, line 4 (emphasis added).

The specification also discloses other subfields of artificial intelligence, such as computational intelligence (based on heuristics algorithms). Examples of computational intelligence include neural networks and fuzzy logic. <u>Hurst</u> at 2. As explained in the Reply to the first non-final Office Action, the specification describes an AI engine employing a neural network:

> . . . On a basic level, neural networks may be based on perception, which may include any sensory information, training data set, and/or [perceptions]. Thus, perception data (entry layer) 1110 may be provided to train AI engine 540. In the beauty product examples, perception data 1110 may represent a wide variety of information,

> including physical attributes, skin conditions, product information, user preferences, and/or expert advice. Through training, AI engine 540 may obtain exit layer 1120, which represents weighted connections of perception data 1110. Knowledge 1130 gained from exit layer 1120 may be stored at any convenient location, including database 510.
>
> In the neural network embodiment of AI engine 540, the connections may take place on any number of layers. . . . An entry layer 1210 may represent a wide variety of information, including, for example, information on a line of products A, a line of products B, or a line of products C. AI engine 540 may process the information from entry layer 1210 to a hidden layer 1220, which in turn is used to generate weighted connections in an exit layer 1230.
>
> . . . Entry layer 1310 may represent any information, including beauty product information. . . . The information from entry layer 1310 may be processed to a hidden layer 1320. Data from hidden layer 1320 may then be processed to generate knowledge in exit layer 1330 of AI engine 540.

Page 21, line 9 - page 22, line 9.

In addition, FIGS. 9, 11, 12, and 13 illustrate an exemplary representation of an AI engine based on a neural network.

For at least reasons set forth above, claims 23, 24, 56, and 57 particularly point out and distinctly claim the subject matter which Applicants regard as the invention. Accordingly, Applicants respectfully request reconsideration and withdrawal of the § 112, second paragraph, rejection of claims 23, 24, 56, and 57.

B. § 102(e) Rejection of Claims 1-10, 13-17, 21, 22, 25, 27-44, 47-55, 58, and 60-72 Based on Voticky

The rejection of claims 1-10, 13-17, 21, 22, 25, 27-44, 47-55, 58, and 60-72 under 35 U.S.C. § 102(e) based on Voticky should be withdrawn. Applicants respectfully submit that the claim rejection is flawed because it appears to rely on the

above-mentioned misunderstanding of the term “conventional artificial intelligence” and the mischaracterizations of Applicants’ remarks. Office Action at 7.

Applicants respectfully traverse the § 102(e) rejection of independent claim 1 for at least the reason that Voticky fails to disclose every claim element recited in claim 1 as reasonably interpreted. Independent claim 1 recites, among other things, “simulating . . . at least one **recommended beauty product** on [a] facial image” (emphasis added). The Examiner asserted that “at least Fig. 9, overlay images, ‘after picture’” purportedly discloses “simulating the at least one recommended beauty product on the facial image.” Office Action at 7. Applicants respectfully disagree.

Voticky discloses a client card that displays “after picture,” as shown in FIG. 9. Voticky also discloses a makeover system that displays an “after picture” on a “finished makeover screen 230,” as shown in FIG. 12. These “after pictures,” however, are not a simulation of at least one **recommended beauty product** on a facial image. These “after pictures” are formulated after completion of the makeover session associated with the screen shown in FIG. 10. The specification of Voticky is very clear that a **user selects** an item to be placed on the image displayed on the screen of FIG. 10. For example, Voticky discloses that “[t]he **user selects** a category option from the list of category option icons 216.” Voticky, col. 8, lines 40-41. Then, “[t]he **user can select** a makeover item from the group of items displayed on the page 200.” Voticky, col. 8, lines 48-50. Then, “[t]he **user selects** an item to place the selected item over the before picture shown in the working area 210.” Voticky, col. 8, lines 51-52. There is no disclosure of suggestion in Voticky that the user, **during** the makeover session, can

select a product to place over the before picture **based on any recommendation** received.

Only after the makeover is completed and the **"after picture" is generated**, finished makeover screen 230 of FIG. 12 provides product recommendations. However, these recommendations are made as a list of products, as shown in FIG. 12, and the recommended products are **not simulated** or displayed on the "after picture" or any other images.

For at least the reasons set forth above, Voticky fails to disclose "simulating . . . at least one recommended beauty product on [a] facial image." Accordingly, Applicants respectfully request reconsideration and withdrawal of the § 102 rejection of independent claim 1 based on Voticky.

Independent claims 22, 36, 55, 68, and 72 recite features that are similar to the features recited in independent claim 1, and thus these claims should be patentable over Voticky for similar reasons even though they have a different scope. For example, claim 36 recites "a simulator that causes on [a] facial image a visual simulation of . . . at least one selected beauty product and . . . at least one recommended beauty product." For reasons similar to those set forth with respect to independent claim 1, the § 102 rejection of independent claims 22, 36, 55, 68, and 72 should be withdrawn. Accordingly, Applicants respectfully request reconsideration and withdrawal of the § 102 rejection of claims 22, 36, 55, 68, and 72 based on Voticky.

Claims 2-10, 13-17, and 21 depend from independent claim 1; claims 25 and 27-35 depend from independent claim 22; claims 37-44 and 47-54 depend from

independent claim 36; claims 58 and 60-67 depend from independent claim 55; and claims 69-71 depend from independent claim 68. Dependent claims 2-10, 13-17, 21, 25, 27-35, 37-44, 47-54, 58, 60-67, and 69-71 are allowable by virtue of their dependence from an allowable independent claim.

Moreover, claims 2-10, 13-17, 21, 25, 27-35, 37-44, 47-54, 58, 60-67, and 69-71 recite further distinctions over Voticky. For example, claim 3 recites that a "recommended beauty product is simulated on [a] facial image while the simulation of . . . at least one selected product appears on the facial image." As set forth above with respect to independent claim 1, Voticky fails to teach that a recommended beauty product is simulated on any facial image. Therefore, Voticky also fails to teach that a recommended beauty product is simulated on a facial image while the simulation of at least one selected product appears on the facial image.

Also, claim 7 recites "receiving from [a] user an affirmative request seeking a recommendation, and wherein the simulation of the recommended product appears on [a] facial image after the user affirmatively seeks a recommendation." Voticky teaches that after a user selects an **exit button**, the system displays an "after image" (makeover image without recommended product on the image) and recommended products merely listed under the image. Applicants submit that selecting an exit button is **not an affirmative request** seeking a recommendation. And, even if selecting an exit button were to constitute an affirmative request seeking a recommendation (a notion Applicants dispute), selecting an exit button does not cause the recommended product to appear on the after image.

For at least these additional reasons, the § 102(e) rejection of the dependent claims should be withdrawn.

C. § 103(a) Rejection of Claims 11, 12, 18-20, 26, 45, 46, and 59 Based on Voticky and Orpaz

Applicants respectfully traverse the rejection of claims 11, 12, 18-20, 26, 45, 46, and 59 under 35 U.S.C. § 103(a) as being unpatentable over Voticky in view of Orpaz. A *prima facie* case of obviousness has not been established with respect to claims 11, 12, 18-20, 26, 45, 46, and 59.

"The key to supporting any rejection under 35 U.S.C. § 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. . . . [R]ejections on obviousness cannot be sustained with mere conclusory statements." M.P.E.P. § 2142, 8th Ed., Rev. 6 (Sept. 2007) (internal citation and inner quotation omitted). "The mere fact that references can be combined or modified does not render the resultant combination obvious unless the results would have been predictable to one of ordinary skill in the art." M.P.E.P. § 2143.01(III) (emphasis in original). "All words in a claim must be considered in judging the patentability of that claim against the prior art." M.P.E.P. § 2143.03. "In determining the differences between the prior art and the claims, the question under 35 U.S.C. § 103 is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious." M.P.E.P. § 2141.02 (I) (emphases in original).

"[T]he framework for objective analysis for determining obviousness under 35 U.S.C. § 103 is stated in *Graham v. John Deere Co.*, 383 U.S. 1, 148 U.S.P.Q. 459 (1966). . . . The factual inquiries . . . [include determining the scope and content of the

prior art and] . . . [a]scertaining the differences between the claimed invention and the prior art." M.P.E.P. § 2141(II). "Office personnel must explain why the difference(s) between the prior art and the claimed invention would have been obvious to one of ordinary skill in the art." M.P.E.P. § 2141(III).

Claims 11, 12, and 18-20 depend from independent claim 1; claim 26 depends from independent claim 22; claims 45 and 46 depend from independent claim 36; and claim 59 depends from independent claim 55. As set forth above with respect to independent claims 1, 22, 36, and 55, Voticky fails to disclose "simulating . . . at least one recommended beauty product on [a] facial image," as recited in claim 1 and similarly in claims 22, 36, and 55.

The outstanding Office Action alleges that Orpaz purportedly "disclose[s] that a first alternative simulated recommendation is displayed simultaneously on the facial image with a display of the at least one selected product, and wherein thereafter a second alternative simulated recommendation is displayed simultaneously on the facial image with a display of the at least one selected product." Office Action at 14 (citing Orpaz, FIG. 4, col. 4, lines 37-50). Orpaz, however, merely discloses that multiple images can be displayed on a screen, and does not disclose that any of the multiple images involves simulating with a recommended product. Thus, Orpaz fails to disclose "simulating . . . at least one recommended beauty product on [a] facial image," as recited in, e.g., claim 1 and thus fails to cure the deficiencies of Voticky.

For at least above reasons, the Examiner has failed to clearly articulate a reason why claims 11, 12, 18-20, 26, 45, 46, and 59 would have been obvious to one of

ordinary skill in the art in view the prior art. Accordingly, a *prima facie* case of obviousness has not been established with respect to claims 11, 12, 18-20, 26, 45, 46, and 59 and the rejection under 35 U.S.C. § 103(a) must be withdrawn.

D. § 103(a) Rejection of Claims 23, 24, 56, and 57 Based on Voticky, Orpaz, and Allegedly Admitted Prior Art

Applicants respectfully traverse the rejection of claims 23, 24, 56, and 57 under 35 U.S.C. § 103(a) as being unpatentable over Voticky, Orpaz and allegedly admitted prior art. A *prima facie* case of obviousness has not been established with respect to claims 23, 24, 56, and 57.

Claims 23 and 24 depend from independent claim 22, and claims 56 and 57 depend from independent claim 55. As set forth above with respect to dependent claims 11, 12, 18-20, 26, 45, 46, and 59, Voticky and Orpaz, taken alone or in combination, fail to teach or suggest "simulating . . . at least one recommended beauty product on [a] facial image," as recited in independent claim 1 and similarly in independent claims 22 and 55.

The outstanding Office Action alleges that "[a]s admitted prior art, previously Officially Noticed, it was old and well know[n] at the time the invention was made to analyze historical data to provide guidance concerning consumer preferences." Office Action at 15. Even if the Examiner's allegations were true, a notion which Applicants respectfully dispute, the allegedly admitted prior art fails to cure the deficiencies of Voticky and Orpaz. For at least these reasons, Applicants respectfully request reconsideration and withdrawal of the § 103 rejection of claims 23, 24, 56, and 57 based on Voticky, Orpaz, and the allegedly admitted prior art.

The outstanding Office Action asserts that Applicants failed to adequately traverse the official notice. Office Action at 3-4. M.P.E.P. § 2144.03 states that "[a] general allegation that the claims define a patentable invention without any reference to the examiner's assertion of official notice would be inadequate." In *In re Boon*, the CCPA held that "there could not have been a proper challenge" because Appellant's correspondence before the Board of Appeals following its decision in the case was not even reproduced in the record before the court. 439 F.2d 724, 728, 169 USPQ 231, 234 (CCPA 1971).

Applicants respectfully submit that Applicants' prior traversal of the alleged admission in response to the first non-final Office Action was adequate because it disputed the Examiner's office notice with specific reference to the Examiner's assertion of official notice. In addition, the holding of *In re Boon* is not applicable in this case because a challenge with reference to the Examiner's assertion was made in the record. Applicants further submit that Applicants' traversal was also reasonable under the circumstance where the Examiner failed to "provide specific factual findings predicated on sound technical and scientific reasoning to support his or her conclusion of common knowledge," as required by M.P.E.P. § 2144.03 (citing *In re Soli*, 317 F.2d 941, 946 (CCPA 1963); *In re Chevenard*, 139 F.2d 711, 713 (CCPA 1943)). The Examiner's mere conjecture that "by having information concerning consumer preferences, a company is better able to serve the public, and be able to provide a powerful and persuasive marketing tool" (first non-final Office Action at 14) is not predicated on sound

technical and scientific reasoning, and did not present with any explicit basis on which Applicants can challenge with further specificity.

IV. Conclusion

Applicants respectfully request reconsideration of this application and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our Deposit Account No. 06-0916.

Respectfully submitted,

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Attachment: An article titled "Overview and Tutorial on Artificial Intelligence Systems" by Jim Hurst (www.giac.org/resources/whitepaper/application/237.php)

Overview and Tutorial on Artificial Intelligence Systems

Jim Hurst

Overview and Tutorial on Artificial Intelligence Systems

Introduction

Humans have a strong fascination with the idea of machines that can think. It is a recurring theme in fiction and the movies, from *Hal* to the *Terminator* to *The Matrix*. Whether a man-made artifact can think is still the subject of debate by philosophers. This paper explores different aspects of term artificial intelligence (or AI) and provides an overview of how this technology is being used today. Defining artificial intelligence is somewhat controversial, because there is no single definition of intelligence. Stanford scholar John McCarthy states that artificial intelligence is "the science and engineering of making intelligent machines, especially intelligent computer programs."

The artificial intelligence community can be roughly divided into two schools of thought: conventional AI and computational intelligence. Conventional AI is based on machine learning, which is the development of the techniques and algorithms that allow machines to "learn" or at least simulate learning. Machine learning attempts to use computer programs to generate patterns or rules from large data sets. This problem is similar to the data-mining problem (and data mining is one area where AI has found commercial success). Machine learning makes heavy use of symbolic formalism and logic, as well as statistics. Key areas in conventional AI include case-based reasoning, behavior-based AI, Bayesian networks, and expert systems.

Computational intelligence, in contrast, relies more on clever algorithms (heuristics) and computation and less on formal logical systems. Computational intelligence is sometimes referred to as *soft computing*. It often involves iterative methods using computation to generate intelligent agents. Whereas conventional AI is considered to be a top-down approach, with the structure of solutions imposed from above, computational intelligence is more bottom-up, where solutions emerge from an unstructured initial state. Two areas of computational intelligence will be discussed further: neural networks and fuzzy logic.

Also, hybrid intelligent systems attempt to combine the two approaches. Some proponents claim that this is appropriate, because the human mind uses multiple techniques to develop and verify results, and hybrid systems show some promise.

Weak AI Versus Strong AI

Another distinction within the artificial intelligence community is weak AI versus strong AI. Weak AI refers to using software to solve particular problems or reasoning tasks that do not encompass fully human intelligence. Strong AI implies creating artificial systems that are fully self-aware that can reason and independently solve problems. Current research is nowhere near creating strong AI, and a lively debate is ongoing as to whether this is even possible.

Neats Versus Scruffies

Another division in the artificial intelligence community is over the best way to design an intelligent system. The Neats maintain that the solution should be elegant, obvious, and based on formal logic. The Scruffies hold that intelligence is too messy and complicated to be solved under the limitations the Neats propose. Interestingly, some good results have come from hybrid approaches, such as putting ad hoc rules (Scruffy style) into a formal (Neat) system. Not surprisingly, the Neats are often associated with conventional artificial intelligence, whereas the Scruffies are usually associated with computational intelligence.

Expert Systems

Conventional AI has achieved success in several areas. Expert systems, or knowledge-based systems, attempt to capture the domain expertise of one or more humans and apply that knowledge. Most commonly, this is done by developing a set of rules that analyze information about a problem and recommend a course of action. Expert systems demonstrate behavior that appears to show reasoning.

Expert systems work best in organizations with high levels of know-how and expertise that are difficult to transfer among staff. The experts explain how they solve problems that are incorporated into the system. The simpler expert systems are all based on binary (true/false) logic, but more sophisticated systems can include methods such as fuzzy logic.

At the heart of an expert system is an inference engine, a program that attempts to create answers from the knowledge base of rules provided by the expert. Knowledge engineers convert a human expert's "rules-of-thumb" into inference rules, which are if-then statements that provide an action or a suggestion if a particular statement is true. The inference engine then uses these inference rules to reason out a solution. Forward chaining starts with the available information and tries to use the inference rules to generate more data until a solution is reached. Backward-chaining starts with a list of solutions and works backward to see if data exists that will allow it to conclude that any of the solutions are true.

Expert systems are used in many fields, including finance, medicine, and automated manufacturing. One expert system that many people may be familiar with is the Microsoft Windows troubleshooting software, accessed by through the help section of the Windows taskbar. This system provides diagnostic advice and suggestions for common user problems.

Case-Based Reasoning

Another approach from conventional AI that has achieved some commercial success is case-based reasoning, or CBR, which attempts to solve new problems based on past solutions of similar problems. Proponents argue that case-based reasoning is a critical element in human problem solving. As formalized in computer reasoning, CBR is composed of four steps: retrieve, reuse, revise, retain. First, access the available information about the problem

(Retrieve). Second, try to extend a previous solution to the current problem (Reuse). Next, test the refactored solution and revise it if necessary (Revise). Finally, store the new experience into the knowledge base (Retain).

Behavior-Based AI

Behavior-based AI (BBAI) is the final methodology of conventional AI considered. Behavior-based artificial intelligence attempts to decompose intelligence into a set of distinct, semi-autonomous modules. BBAI is popular in the robotics field and is the basis for many Robocup robotic soccer teams, as well as the Sony Aibo.

A BBAI system is composed of numerous simple behavior modules, which are organized into layers. Each layer represents a particular goal of the system, and the layers are organized hierarchically. A low layer might have a goal of "avoid falling," whereas the layer above it might be "move forward." The move forward layer might be one component of a larger "walk to the store" goal. The layers can access sensor data and send commands to the robot's motors. The lower layers tend to function as reflexes, whereas the higher layers control more complex goal-directed behavior.

Bayesian Networks

Bayesian networks are another tool in the conventional AI approach. They are heavily based upon probability theory. The problem domain is represented as a network.

This network is a directed acyclic graphic where the nodes represent variables, and the arcs represent conditional dependencies between the variables. Graphs are easy to work with, so Bayesian networks can be used to produce models that are simple for humans to understand, as well as effective algorithms for inference and learning. Bayesian networks have been successfully applied to numerous areas, including medicine, decision support systems, and text analysis, including optical character recognition.

Neural Networks

There is no widespread agreement yet on exactly what Computational intelligence (CI) is, but it is agreed that it includes neural networks and fuzzy computing. A neural network consists of many nodes that cooperate to produce an output. The system is trained by supplying input on the solution of known problems, which changes the weighting between the nodes. After training has tuned the parameters between the connections, neural networks can solve difficult problems in machine vision and other areas.

Also known as neurocomputing, or parallel distributed processing, neural networks loosely model structures in the human brain. Neural network outputs rely on the cooperation of individual nodes. Data processing in neural networks is typically done in parallel, rather than sequentially as is the standard for nearly all

modern computers. Neural nets can generalize from their training, and solve new problems, so they are self-adaptive systems. Neural networks have been criticized as "bad science" because it is difficult to explain exactly how they work. Nonetheless, neural networks have been successfully applied in areas as diverse as credit card fraud detection, machine vision, chess, and vehicle control.

Fuzzy Logic

Fuzzy logic, fuzzy systems, and fuzzy set theory are all ways to refer to reasoning that is based upon approximate values, rather than precise quantities. Modern computers are built upon binary, or Boolean, logic that is based on ones and zeros. The bit is zero or one, yes or no, with no middle ground. Fuzzy systems provide for a broader range of possible values.

Consider the question, "Are the books in the study?" Well, yes, there are books in the study. There are also books in the office, books in the bedroom, and a pile of books in the doorway to the study. Fuzzy logic provides for an answer of 72%, meaning that 72% of the books are in the study. Fuzzy sets are based on vague definitions of sets. They are not random. Fuzzy logic is not imprecise; rather, it is a formal mathematical technique for handling imprecise data.

Like neural networks, fuzzy logic is subject to controversy and criticism. But systems based on fuzzy logic have an excellent track record at certain types of problems. Antilock braking systems are based on fuzzy logic, and many appliances incorporate fuzzy logic. The artificial intelligence systems used in nonplayer characters of modern video games often used fuzzy logic.

Summary

This paper has provided an overview of artificial intelligence and its applications. Artificial intelligence is not a single thing; it is many things. A distinction is often made between conventional artificial intelligence, which is based upon machine learning, and computational intelligence, which applies iteration and computation to generate intelligent agents. Conventional AI relies on symbolic logic and formalism and is considered a top-down approach. Computational intelligence, sometimes known as soft computing, uses training based on empirical data and is more of a bottom-up approach.

Four areas of conventional AI were examined. Expert systems use rule-based inference engines to simulate reasoning. Case-based reasoning tries to apply previous experience to the current problem. Behavior-based AI uses sets of semi-autonomous agents to solve problems. Bayesian networks model knowledge by using probabilities and graph theory to draw inferences.

Two types of computational intelligence systems were examined. Neural networks consist of networks of cooperating nodes that are trained by a series of inputs. Fuzzy logic is a system of logic that allows for imprecise information and solves problems with incomplete information.

All these techniques have successful applications in use today. Artificial intelligence is improving our lives in numerous ways, even when there is no widespread agreement on exactly what artificial intelligence is.

References

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What Is Computational Intelligence? Computational Intelligence Group, Department of Computer Science, Vrije University. http://www.cs.vu.nl/ci/.